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Accessibility of Self-Service Technology

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Abstract

With the technology evolving at today's fast pace, and the world becoming more digital, services are becoming more digital as well. With digitalization of services, more services become self-service, but is the self-service technology accessible? Most people want to be independent, and don't like asking for help, however that will not be possible for many if the services they are trying to access are not universally designed. This becomes a bigger issue as the population ages, the life expectancy rises and as we get older, our abilities deteriorate.

These are the questions and issues that will be explored in this thesis, with focus on self-service technology. This is accomplished through a literature study, where other papers related to the subject matter are explored. Followed by qualitative interviews, interviewing people with disabilities about their experiences with self-service technology, and finally performing heuristic testing. The findings from this research revealed widespread issues when it comes to guidelines, standards, and regulations, but also major accessibility barriers in most self-service technology. This subject matter needs more research in the future, as it is a very broad topic, and it is a big part of today's technology.

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Preface

Kommentert [TG1]: Perfekt :)

In 2019 I worked on a project to develop an interactive self-service information screen that was to be used in the new information center at the Gardermoen airport. While working on this project, I found it difficult to figure out how to make it universally designed. The physical shape and measure of the machine itself was out of my control, what I could control was the user interface on the screen. I found it difficult to find resources and guidelines that helped me make this self-service technology I was working on, universally designed. This was my main inspiration and motivation for this thesis.

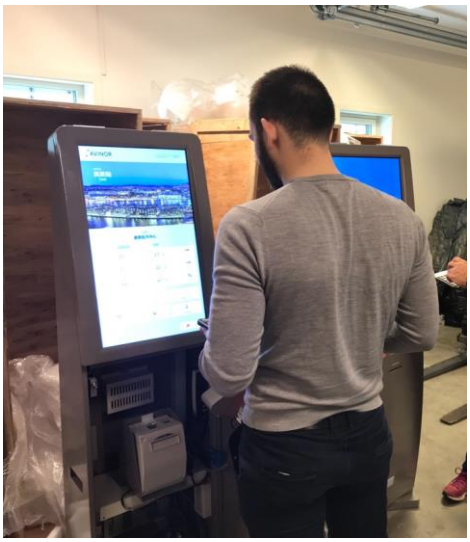

Figure 1 Development and testing of the self-service information screen

I would also like to extend my gratitude towards people who have helped me out during the last years with the thesis. My supervisor Terje Gjøsæter, Ph.D has been very helpful and supportive throughout this project, offering both his expertise and friendship. I would also like to thank my colleagues at Bouvet, who have offered me help during this project, especially Lena Drevsjø and Martin Trehjørningen who helped me out with the heuristic testing. My gratitude also goes towards the people who participated in the interviews and shared their valuable experiences.

Lastly, I wish to thank my family and friends who have inspired me and motivated me, especially during the time of lockdown and global pandemic.

1 Introduction

Technology is rapidly evolving and changing the world, becoming more digital. Information and services are available at our fingertips and more of our everyday tasks are becoming easier and more automated thanks to digitalization. While a lot of the services are now available on our personal devices such as personal computers or smart phones, some of these services are offered as kiosks and self-service terminals. These self-service terminals give the users easier access to the service they are offering. For example, adding ticket machines at a train station can reduce the amount of time one has to wait to be able to buy a ticket compared to only having manned ticket booths. Even though people still prefer to talk to an employee to receive the service they are seeking (Dean, 2008), companies and organizations have great benefits from these self-service terminals, such as reduced costs and the ability to offer their service 24/7.

Self-service technology (SST) is all technology that enables customers and users to access services directly and independently without involving employees. Many different devices and machines fall under the SST category, for example vending machines, ATMs, ticket machines, kiosks, terminals, interactive information screens and the list goes on and on. The complexity of SSTs also varies greatly, where some SST might just be a mounted tablet such as an iPad, with specialized software to provide the service, others might be large complex kiosks with large interactive screens, payment terminals, printing, and scanning capabilities and much more. There are also many terms attached to “Self-service”, such as aforementioned “Self-service Technology”, but also “Self-service terminals”, “Self-service machine”, “Self-service kiosk” and many more that are interchangeable and can often be used to describe the same object.

As the digital counterparts of services become more widespread, the physical and human aspect of these services start to become less available. This poses a great challenge if the SST are not universally designed and made accessible for everyone. As the physical world and the digital world are trying to strive towards universal design, these digital screens are a mixture of both. These machines are created to make it easier for people to use some services, to make people more independent. If these machines are not universally designed,

they are not fully accessible or completely inaccessible to the ca. 15% of the population that are living with a disability and with some services no longer have the option to talk to an employee to get the services they need[1]. And with the aging population, the number of people with disabilities will increase with time. When all these factors are considered, one can see that the importance of universal design of SSTs will grow more as time goes by.

The term disability can be used to cover many different things such as physical, mental, and psychological impairments. According to World Health Organization (WHO), a disability is any condition of the body or the mind that makes it more difficult for a person with that condition to do certain activities, which is also called activity limitation, or the difficulty of interacting with the world around them, which is participation restriction. Someone having difficulties performing a task, for whatever reason, that others can perform with ease has a disability. It is a mismatch between a person's abilities and the accessibility of something that the person is trying to use or access. One way of looking at it is that this is a disability that a person has, while a more productive point of view is that it is an accessibility barrier that the system has. So, a disability can be something that is put on a person by the society (Jones, 1996).

There are several disability models. We have the Medical Model which looks at disability as a consequence of a health condition, disease, or trauma, which restricts the person in a physiological or cognitive way. The Social Model of disability says that a disability is the fault of the environment. In this model, the physical or cognitive limitations of a person is not the problem, but rather it is the environment that is not accommodating that is the problem. Another way of looking at disability is the combination, which is sometimes referred to as the Gap Model. In this model it is the gap between the person's ability and the limitation or lack of accommodation of the environment that is the main problem.[2]

There are many different accessibility barriers that people can face, some are more severe than others and there are many factors to consider when trying to design something to be

[1] According to WHO, over a billion people, about 15% of the world's population live with disability. https://www.who.int/en/news-room/fact-sheets/detail/disability-and-health
[2] The Conceptual Models of Disability. https://now.aapmr.org/conceptual-models-of-disability/

universally designed. For example, being blind is the most severe type of vision impairment, and most people with severe vision impairment use screen reader technology to use computers and phones in their daily lives. While screen readers can help them navigate websites and apps, if the websites and apps are not made to be accessible, these screen readers will be of little help. When it comes to SSTs, a blind person will need the help of a screen reader technology to be able to know what is shown on the screen. In most of the cases, the location of these machines might be out in public where there is a lot of background noise, or where having a loudspeaker on the machine is not an option. The reason as to why this is not an option is because of the background noise, making a loudspeaker inefficient, it can be disturbing to other people around the area and for privacy reasons. In such case, the blind person would need to have his or her own personal headset and the ability to connect said headset to the SST.

Another issue is that many of these SSTs are touch-based, and do not provide any tactile or haptic feedback to users, so on top of not being able to read what is on the display, people with severe visual impairment will be unable to interact with the machine at all. And if the display is placed at a height where it is accessible to wheelchair users, it might pose a challenge for users that are tall.

Automated Teller Machines (ATMs) are a type of SST that has been around for several decades and have had great improvements when it comes to accessibility over the years. These have tactile buttons, AUX port and screen reader technology built in, which is great for accessibility. When it comes to SST accessibility, ATMs became a de facto standard. Most of the ATMs have a braille on buttons and even a phone number written in braille that users can call for assistance.

1.1 Problem statement

In a world where technology is becoming a bigger part of our lives every day and helping to make our daily lives easier, we want this to be true for everyone, as such this technology needs to be accessible for everyone.

Since the SSTs are a combination of both physical and digital interfaces, creating these universally designed might be a challenge. There are a lot of design principles and accessibility guidelines that can be followed for digital interfaces and there are such principles and guidelines for accessibility of physical world as well, but there are few resources available as to how to make the combination of these two accessible. In this thesis, the guidelines and regulations that are available on Digdir website will be used to evaluate how accessible some of these SSTs are in Norway, and what can be done to make them more accessible.

1.2 Research Questions

This research is aimed to answer questions regarding the accessibility of self-service technology, what makes self-service technology inaccessible and if the existing guidelines and standards are sufficient to make self-service technology accessible if they are followed.

1. What guidelines are available for universal design of SST?
2. What major barriers do users face when using the SSTs?
3. Which characteristics makes an SST inaccessible?

In order to answer research question 1, a thorough literature study was conducted. Interviews and heuristic testing were done to answer research question 2 and 3.

2 Literature Study

In the literature research section, research on the topics of accessibility, disabilities and accessibility of self-service terminals will be presented. The research will start with disabilities and general accessibility and how they have improved and changed over the years.

2.1 Disability

According to WHO's "World Report Disability", in 2010 there were over a billion people living on this planet with some form of disability (World Health Organization & World Bank, 2011). That was at that time around 15% of the world population. This number has grown over the years in America (Houtenville & Boege, 2019). One of the major factors in the increase is that the life expectancy has increased worldwide over the years and statistically the older a person gets, more likely are they to get some form of disability. While 15% of the world population has a disability, more than 46% of people who are 60 years or older have disabilities. From the year 2015 to the year 2030, the population that is 60 years or older is expected to grow by 56%.[3]

2.2 Accessibility

Accessibility in general, has been around for a while, and it got more focus in the 1960s with new standards, legislation, and regulations for entrances to public buildings, toilet rooms, elevators, and such. Many of the accessibility rules were bundled together with health and safety regulations of for example buildings in many countries. First standard in the US was the ANSI A117.1 Accessible and Usable Buildings and Facilities in 1961. In 1964, the US enacted the Civil Rights Act which made discriminating someone based on race, sex, skin colour, national origin in public places illegal (Wiley, 2015). If one cannot get access to a service based on their race, skin colour, sex, or birthplace, then the discrimination that they

[3] Numbers from Ageing and disability on the UN website: https://www.un.org/development/desa/disabilities/disability-and-ageing.html

are facing is a form of disability. Over the years, more regulations came into effect all over the world, prohibiting discrimination based on disability. Accessibility of public space, buildings, infrastructure, transport has gotten more attention and governments have implemented standards and regulations (Zając, 2016).

While the internet became more and more used in the 90s, many social and economic activities moved on to the internet. These activities that were defined under civil rights legislations and had been given the responsibility to accommodate individuals with disabilities, such as making sure a building has elevators, entrances having wheelchair ramps, braille on some signs and ATMs. Now that these activities had moved to a new platform and had become digital, there was a new challenge. The web standards organization World Wide Web Consortium (W3C) was founded in 1994 by Tim Berners-Lee, who was the inventor of the World Wide Web (Ismanalijev, 2016). Before all this, the web developers would do their best to make their websites accessible by accommodating people based on the specific needs of said people. This was the time where the layout of a website was created by using HTML tables. This is also the time where Cascading Style Sheets (CSS) started to be used in order to have the content of the page and the design separated, making it easier for screen readers. This was a difficult and inefficient way of making the web more accessible, and there was a need for web accessibility standards. In the coming years, the W3C started a project to create these standards and in 1999 they released the first version of Web Content Accessibility Guidelines (WCAG).

Perhaps the biggest thing that has happened for accessibility is the UN's Convention of the Rights of Persons with Disabilities, which was the first human rights treaty of the 21st century. This treaty did a lot for the equality and rights of people with disabilities, making access to information a human right (UN General Assembly, 2006). Most of the world's countries have signed this treaty and most of them have ratified it. This convention follows the principle that "all human rights are universal, indivisible, interdependent and interrelated". This served as one of the reasons for a global movement to view people with disabilities as equals members of society. Many countries implemented and/or updated their own laws that would prohibit discrimination and promote accessibility, such as Norway's Anti-Discrimination and Accessibility Act of 2008 ("Anti-Discrimination and

Accessibility Act," 2008). In the same year, W3C also released WCAG 2.0, which many countries used as a reference to improve web accessibility and included it, or derived their own standards based on it.

Many of these discrimination laws that exist around the world open up the opportunity for people to sue business and establishments that are inaccessible on the basis that they are discriminating against them, and few of the countries enforce the rules themselves. Norway's "Norwegian Agency for Public Management and e-Government", which is now the Digitalisation Agency after merging with "Altinn", a data management section of the government conducts tests and assesses the accessibility of Norwegian websites. If the websites do not meet the standards of web accessibility, this government agency fines the owner of the website. Even though they do not conduct that many tests yearly, it is very beneficial because the websites that are tested will improve their accessibility to avoid getting fines.

2.3 Universal design

The term "Universal design" (UD) was first used by Ronald Mace, the Director of the Center for Accessible Housing at North Carolina State University. Being a wheelchair user himself and an architect, Ronald introduced the concept of universal design to the Department of Housing and Urban Development in the US. The existing housing had too many barriers at that time and the goal was to have housing that was universally usable (Null, 2013). Ronald stated the differences between "Barrier-free design", "Universal design" as being; while barrier-free design focuses mostly on removing the barriers for people with disabilities, and has only people with disabilities, and their accommodation in focus, universal design focuses on all people. According to him, universal design assumes that everyone has a disability, and the reasoning for that is that we all become disabled as we age and lose ability.

A resolution adopted by the Committee of Ministers of the Council of Europe in 2001 and again in 2007 defined universal design as "… a strategy that aims to make the design and composition of different environments and products useable for everyone. It attempts to do this in the most independent and natural manner as possible, without the need for

adaptation or specialized design solutions. The intent of the universal design concept is to simplify life for everyone by making the built environment, products, and communications equally accessible, useable, and understandable at little or no extra cost. The universal design concept emphasizes user-centered design by following a holistic approach to accommodate the needs of people of all ages, sizes, and abilities."

To help achieve universal design, universal designed advocates from "The Center for Universal Design" developed a list of principles. There are 7 principles for Universal design:

1. Equitable use
    a. Same means of use for all user
    b. Avoid segregating or stigmatizing any groups or individuals
    c. Privacy, security, and safety equally available to all
2. Flexibility in use
    a. Choice in methods of use
    b. Adaptable
3. Simple and intuitive
    a. No unnecessary complexity
    b. Consistent with user expectations and intuition
    c. Accommodates wide range of literacy and language skills
4. Perceptible information
    a. Provides information effectively regardless of user's abilities
    b. Adequate contrast
    c. Different modes for redundant presentation
5. Tolerance for error
    a. Fail-safe features
    b. Warnings of hazards and errors
    c. Minimizes consequences of accidental actions
6. Low physical effort
    a. Minimizes physical effort
    b. Minimizes repetitive actions
    c. Effective use and without fatigue
7. Size and space for approach and use

a. Everything is within reach, regardless of seated or standing position of user
b. Enough space around object
c. Accommodates for all sizes of bodies.

2.4 Universal Design of ICT

Universal design of ICT is the application of the universal design principles in a context of "Information and Communications Technology" (ICT) and in doing so, making the ICT system usable by all, to the greatest extent possible. There are many legislations that try to enforce and ensure universal design of ICT, however there are many challenges that one faces when trying to make an ICT system universally designed. Some identifying issues were that UD of ICT could be understood differently from person to person, lack of UD focus and awareness. Several solutions have been proposed by researchers, such as creating a best practice "how to" guide for UD in projects, a definition of UD that is regulatable and implementable by being measurable and documentable. Other solutions focus on education and training of professionals, more legislative measures and enforcing those measures (Miriam Eileen Nes Begnum, McCallum, Nowostawski, & Alsos, 2019). Research has also identified 84 characterizing factors that ensure that ICT-projects are universally designed (Miriam E. Nes Begnum, 2018). 15 of which are considered to be "Critical Success Criteria". This was achieved by interviewing 34 people who worked on 23 different, UD award-winning ICT projects. All the characterizing factors were split into 4 categories: Societal, Organizational, Processual and Personal. By involving theories from (Herzberg, 1964) and (Fogg, 2009), the author went through the interviews and mapped empirical factors for UD success. Both theories focus on the motivation of people. Hertzberg has a dual-factor theory that has employee motivation in focus and the factors that make employees be satisfied or dissatisfied at work. The factors he used were what he called motivating factors or hygiene factors. Fogg has a model for human behavior, which is characterized as "B=MAP" (or "B=MAT" in some cases, where T stands for Trigger), "Behavior (B) happens when Motivation (M), Ability (A), and a Prompt (P) come together at the same moment". Simply

this means whether a user can complete a task is the combination of if the user is motivated enough, has enough ability to succeed.

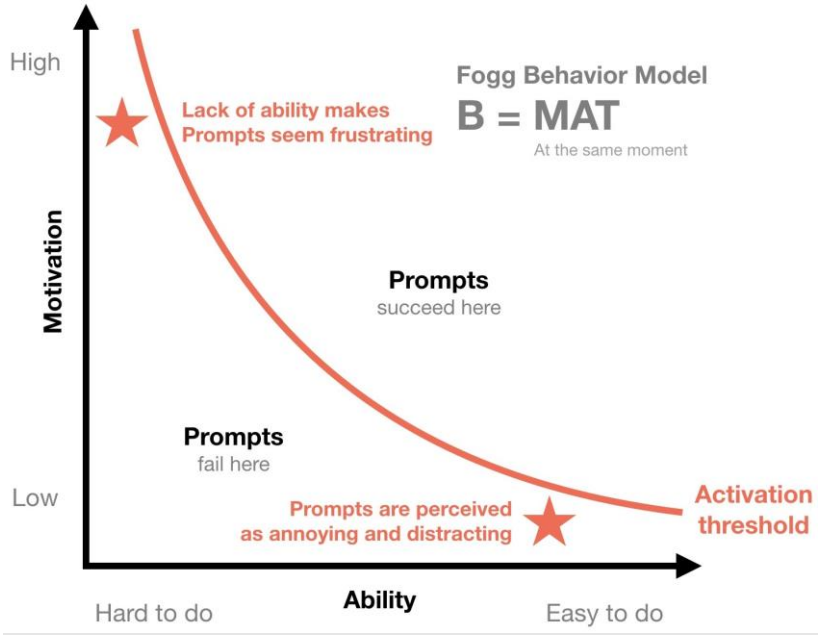

Figure 2 Fogg Behavior Model. Retrieved from: https://ui-patterns.com/blog/making-the-fogg-behavior-model-actionable on 09.05.2020

By applying these two theories to the characterizing factors the researcher was able to identify which of these are hygiene factors, and which are motivating factors, and which are triggers. Three steps to promote UD of ICT were proposed; “Legal interventions to enforce a minimum level of UD”, “Awareness interventions to inspire maximized UD priority” and “Training interventions to facilitate UD grass-root movements”.

Involving the users is important when it comes to trying to create something that is universally designed, this is also true for when trying to create ICT that is universally designed. By involving some users during the development process, their needs can be identified which sometimes can be conflicting to some other users’ needs, and this forces the developers to think differently. This results in a couple of different things, one is that it raises awareness about the needs, differences and expectations, another thing is that due to being able to see the problem from different user perspectives, it can often lead to innovative solutions (Garofolo, Medvet, Babich, & Ramponi, 2017). This is what universal design is about, innovating and coming up with smart solutions that enable all users to use the product to the greatest extent possible.

2.5 Self-service Technology

The first modern self-service machines were coin-operated vending machines that sold postcards in the 1880s in London (Chandler & Hikino, 1994). After the 20th century started, technology evolved, and different self-service machines started popping up. Self-service gas pumps, ATMs, self-service checkout machines in retail stores. Today we have a self-service machine for almost any service that exists out there, such as self-check in machines at the airports, interactive information kiosks, machines to buy cinema tickets, rental cars, public transport tickets. A few of present self-service machines might use proprietary operating system and software, but most of them use known operating systems such as Windows, Apple, Android and ChromeOS (Summers, 2014). On top of these operating systems, they usually have a kiosk software that restricts functionality and access of the machine, putting it in a kiosk mode. Many of these machines, because of the restrictions put upon them by the kiosk software have very limited input methods. While personal computers and devices using these operating systems have assistive technology that can be used with the

computers and devices, the self-service machines often do not have this, due to the restrictions. While some SSTs are computers with the built-in kiosk mode on the operating system enabled and have a keyboard available for the users, others have only a touch enabled monitor. These machines with the touch enabled monitors have keyboards that operators and support staff can use to configure the machine or fix the machine if a problem arises. If the users got to use their own assistive technology with the machines, it means that the users could potentially be able to go out of the kiosk mode with a few keyboard shortcuts (Kruper, 2014).

According to a study, self-service technology is used by companies to satisfy and retain customers, creating a financial return for the company. From interviewing employees at the companies, interface design and accessibility are found out to be two out of five key success factors for self-service terminals (Cho & Fiorito, 2010). Accessibility in this paper and context was referring to the location of the kiosks and not necessarily universal design of the kiosk. The accessible placement of self-service terminals is an important factor.

2.6 Guidelines, Standards and Legislation

"Accessibility of self-service terminals in Norway" is a short, yet very relevant paper. This is the paper that is indirectly mentioned in the "Problem Statement" section of this paper. It describes how the employees at Funka came up with the guidelines on how to accessibly place SST in an environment (Cederbom, Laurin, & Gejrot, 2018). The existing regulations and standards in Norway that were related to the accessibility of SSTs were hard to read and hard to understand. The information in these standards were compiled and user interviews were conducted in order to harmonise this information into an easy-to-use guide regarding the placement of SSTs. The shortcomings of this research are discussed in this paper, which are that they only focus on the placement of the machines and not any other aspects of it. There is nothing about the software of these SSTs or other conditions of the surrounding areas where the SSTs are placed.

The European Accessibility Act which became law in 2019 has self-service terminals and similar technology in focus. This act tries to both ensure full participation of people with disabilities in society and tries to reduce the fragmentation of legislation regarding

accessibility of services and products (Petrie & Darzentas, 2018). This provides a common EU definition of "implementing framework for, accessibility requirements for certain products and services" and aims to provide a clearer definition of general accessibility requirements in existing European law. It provides principles and not detailed technical solutions.
Accessibility issues for SSTs can be split into 3 categories: placement of the SST, hardware, and the physical attributes of the SST and lastly the software.
In 2018, a conference paper did case studies exploring the practical challenges of implementing standards and guidelines on self-service machines (Jokisuu, Day, & Rohan, 2018). First case study was about tactile buttons on ATMs where they found out that the use of Braille on these buttons had their own challenges such as the fact that not all visually impaired people can read Braille, the use of Braille is declining and the ability to read Braille is degraded in cold conditions, which is a problem due to many ATMs being outside. The solution was to use raised symbols such as X for cancel operation, circle for enter/confirm, line or arrow for clear/correct. They campaigned for this to become a standard and is now codified in several laws and standards such as the UK ATM guideline, ADA, and the European Bankers keyboard standard. It is also used in other contexts other than ATMs, for example payment machines in retail. The important thing here was to involve all parties and give and get feedback.
Second case study explores on how to make touchscreen PIN entry accessible. In this study they discuss the conflicts between privacy/security and accessibility. For example, if the card entry slot is made big, then it is better for accessibility because it does not require as much dexterity to put a card in there, but on the other hand, it might mean that there is a chance that fraudulent devices are inserted into it. The example that they focus on in this case study is that visually impaired people rely on that the ATM tells the user what is on the screen vocally, but this poses a security risk when it comes to the user inserting their PIN code. If the user has tactile buttons to enter their PIN with, it is not a problem, but if they must do it on a touchscreen, then they have no way of knowing which digit they entered without the ATM giving vocal feedback. The existing standards are discussed and how they might inadvertently restrict innovation, and how standards should provide helpful guidance without restricting innovation. Another problem is that most of the SSTs are closed systems, which means they do not allow the users to add peripherals or use software (e.g., assistive

technology) to access the SSTs functionality.

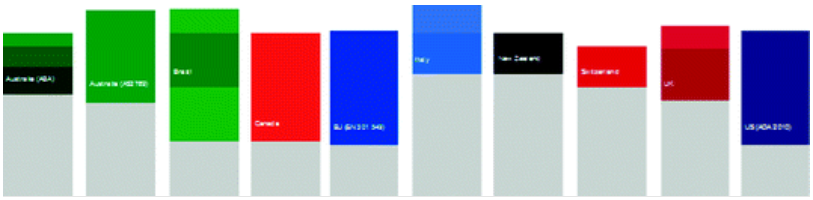

Figure 3 Height requirements for ATMs in different standards. Source: Jokisuu, E., et al. (2018)

The last case study in this conference paper looked at the lack of harmonisation of standards. The existing standards are unharmonized and give different guidelines and requirements, sometimes conflicting. These inconsistencies are for example the different minimum and maximum height requirements as illustrated by Figure 3. An example solution was suggested for the lack of harmonisation to adopt the requirements for software from WCAG, while extending them to differentiate between open and closed systems.
A recent article also addresses the issue of disharmony in the accessibility guidelines for SST and working on unifying them (Lazar, Jordan, & Vanderheiden, 2019). By gathering existing guidelines and working towards harmonizing them, they are creating categorized guidelines, similar to that of WCAG. Some of the categories being “Visual Output”, “Audio Output” and “Input and Operation”. In each category they have set of guidelines, and for each guideline they have a flag to indicate whether it is hardware provision or software provision.

2.7 Automatic Teller Machines

A conference paper from 2018 about improving ATM accessibility by transferring the interface and interaction to personal accessible devices points out a lot of the existing accessibility barriers on ATMs (Zaim & Miesenberger, 2018). Most of the issues vary from ATM to ATM, some have contrast settings and interface enlargement or zoom, while others do not. Most of ATMs might have screen reader functionality and a plug for earphones, but how users interact with the machine varies from ATM to ATM. And the environment where the ATMs are placed might be a big factor due to noise. One of the major issues is often requirements that are contradictory, something that helps one user, might make the interaction more complex and difficult for another user. An example of this is where a user interface that is designed so that people with low vision and lower cognitive capacity are

able to use it, can make it unpleasant and slow when used by people with no disabilities. Another major issue is the pressure someone with a disability might feel in public space when trying to use an ATM because they might not be as fast and effective when using it when compared to someone with no disabilities.

One solution to a lot of these problems was to transfer the interface and interaction to a personal device. Most people have a personal smartphone that they are proficient in using and it works as an Assistive Technology (AT). These can be personalized to fit the needs of the user. Using this method, one can eliminate most of the problems when it comes to accessibility in interaction with ATMs and other SSTs. All that remains is to create a software on these devices, following all the standards and guidelines that exist on how to make these software or web applications accessible. Initial usability tests showed vast improvements in usability during their study.

2.8 User Input on Self-Service Terminals

When it comes to user input on self-service terminals, there has been done extensive research on the different types of machines and kiosks. A very relevant example of this research is an article where the input on touch-based self-service kiosks and transportation apps is in focus and the goal is to improve the robustness to input errors. Self-service kiosks are widespread in the transportation industry and are often used to sell tickets without the need of manned kiosks 24/7. There are often apps where the users can access the same service and buy tickets as well, and often coexist with the self-service kiosks. The focus of the study is the step where the user inputs the destination name or station name (F. E. Sandnes, 2018). Although there are alternatives such as showing a small list of the most popular destinations and stations, some users are forced to input the name of the station manually. This is where some challenges arise, such as if the users have limited experience with the system and as mentioned earlier might feel the pressure due to being in a public space and not being able to use the self-service terminal as effectively as someone who is more experienced with it. Other issues might be that the touch displays of these kiosks might be of low quality, or worn out from use, or mis-/uncalibrated, making touch precision less accurate. There might also be challenges when it comes to the software part of the kiosk, such as alternate names for stations that most likely only locals know, such as “Oslo S”

for “Oslo Central Station” or “Gardermoen” when referring to “Oslo Airport”. Four methods are considered, motor input errors, where the user accidently presses the neighbouring targets, difficulty of writing long words, cognitive disability of a user such as dyslexia and a mixture of motor and cognitive disability. This article does not take into account if the user has reduced vision and the challenges that it brings with it. 5 different input strategies are testing on a list of 324 train stations. The methods are “Fuzzy key”, “abbreviations”, “bag-of-letters”, “fuzzy bag” and “Levenshtein distances”, where the last one is found to be the best based on balance of simplicity, number of keystrokes and robustness to errors.

The challenges and a solution for touch-based input for people with visual impairment is explored in another study. Due to touch-based input being visually intensive and overall touch-based technologies being often inaccessible to users with severe visual impairment or blindness, gesture-based input methods are explored (F. Sandnes et al., 2012). The issue with touch-based kiosks is that most of them have absolutely positioned buttons on the screen without any tactile indication or audio cues as to where they are positioned on the screen, making it impossible for someone who is blind to locate them. Gestures work on most modern touch screens that are multi-touch displays and does not usually require any additional modifications on the machine except for a software upgrade. While handheld devices that use touchscreen as their only method of input are accessible through the use of gestures and screen-reader technology, the same method does not directly translate to public kiosk and pose some challenges due to the difference between a personal handheld device and a public kiosk.

The main challenge being the learning curve, the fact that most users do not use the SST frequently and the uncomfortable nature of being in public where others are waiting to use the machine as well. The touch capabilities of most smartphones are usually more advanced than the ones on most SSTs. The study was done using a prototype self-service train ticket kiosk and was tested by 25 participants without a visual impairment and 16 individuals with visual impairment. Some of the participants without visual impairment were blindfolded. The task was the same for each participant was the same, to buy a ticket from one city to another. All participants were able to complete the task during this experiment. When the users were interacting, audio feedback was given to the participants with synthetic speech. This poses the challenges as mentioned earlier with audio feedback in public places, and noisy environment.

2.9 Universal Design of self-service kiosks

The universal design of self-service kiosks is an excellent goal to strive towards, but very challenging to reach. One attribute that might benefit one type of user, might make it harder for another user, like previously mentioned example of height that is accessible for wheelchair users might make it uncomfortable for tall users. There are many factors mentioned in a study where the goal is to create accessible self-service machines through intelligent user interfaces that adapt to the users (Hagen & Sandnes, 2010). One factor is the previously mentioned height of the interface, another one is size of the text and interface, where large text and large buttons might be beneficial for some users with reduced vision, it might be infringing on the privacy of the users because people around them are able to read what is on the screen too. It might also be embarrassing for users without a visual impairment to use an interface with large text.

Another study was conducted in China to improve the usability of the user interface on hospital self-service registration kiosks. The study did this by having the users complete the registration through a series of well-defined steps, through personalized shortcut options and group recommending options, achieving an adaptive user interface (Hwang, Wu, Ding, Ko, & Huang, 2017). This requires the users to use the kiosk several times in order to gather data about the user's preferences and adapt the interface accordingly.

The physical aspect of SSTs must be universally designed as well, and some of these require the user to perform complex tasks, such as self-checkout at retail stores. A study done in 2006 on self-checkout stations for users in wheelchairs tested a prototype to improve the design (Bajaj, Mirka, Sommerich, & Khachatoorian, 2006). The study employed the principles of universal design to try to make the self-checkout process universally designed. With the goal of improving accessibility and usability for people who are using a wheelchair, without reducing them for non-wheelchair users. The study primarily focused on the two first principles of universal design, equitable use, and flexibility in use. Today we can see aspects of this redesign in retail stores with self-checkout, where interactive screen is usually closer to the user, and not so far down that tall, standing users feel discomfort using them.

3 Research methodology

Given the characteristics and complexity of the research, qualitative research methods were used to answer the research questions. If it is inaccessible to one person, then it simply means that it is inaccessible. If we use qualitative research methods, we can dig deeper and understand why a piece of technology is inaccessible, what makes it inaccessible. With qualitative research, we can analyze a complex problem and gain a deeper understanding and create a clearer picture (Almeida, Faria, & Queirós, 2017).

In order to find out which major barriers users face when using self-service technology, people with disabilities were interviewed. And the fact that there is a limitation when it comes to how many participants are available for interviews about the given subject, is another reason to choose qualitative over quantitative.

3.1 Interviews

3.1.1 Choice of interview type

To answer the first research question, an open-ended and semi-structured interview, which is sometimes known as a qualitative interview was conducted. Due to the scope of the research question, given that there are so many different types and categories of self-service machines, this is the best form of interview in order to do extended data collection from subjects. This form of interview is also very suitable because the focus is on the subjective human experience, allowing the interview subjects to speak for themselves and their experiences and increasing the validity of the data (Mathers, Fox, & Hunn, 2000).
The scope of the research is a major factor when it comes to the choice of interview as well. If the scope was narrowed down before the interviews and we chose to focus on some self-service terminals and machines over others, then we might have ended up with asking the participants about their experience with a specific self-service terminal or machine, without the interviewees having had any experience with that particular machine. Therefore, it was more valuable to have an open-ended and semi-structured interview both to get an in-depth

understanding of their experiences, but also help narrow the scope of the research by finding out which machines most of the participants had experience with and focus on them. Another reason to go with qualitative type of interview is due to the nature of the research and the subjectivity of the participants (Edwards & Holland, 2013). Looking back at the BJ Fogg's Behavior Model, we see that one's ability is not the only factor when it comes to whether they succeed at any given task or not, motivation is also a giant factor. For example, if two people with similar level of dexterity are trying to perform a task, where one is very motivated to perform said task, and the other one is not motivated to do the task, then one will succeed and the other one might not. In this example, the person failing the task might feel as though this is due to the task being inaccessible.

3.1.2 Participants

The criteria for the participants were chosen based on research and findings from the literature study in the first phase. From that, we could decide which type of impairment and disability would most likely face major barriers when using self-service technology. The type of disabilities that were chosen as focus were motor disabilities and visual disabilities. For ethical reasons which are more expanded upon in the Ethical Concerns and Considerations section, participants with cognitive disabilities were not included as potential participants in the interview. People with motor disabilities were very likely to face barriers due to there being many factors that might pose them difficulties such as inaccessible placement of the machines, physical shape, and design of the machines. People with visual impairment might face difficulties due to the machines being an unknown medium for them which makes it difficult for them to navigate the digital user interface of the machines or find the location of physical buttons on the machines.

Other criteria were that the interviewees had to be over the age of consent, due to them having to fill out a consent form which gave them information about the project, the interview, and their rights.

3.1.3 Recruitment

Many colleagues work with accessibility and universal design and have vast professional networks. These colleagues provided some leads, both of people with disabilities that they

knew and organizations for people with disabilities that should be reached out to in order to find participants. The following organizations were reached out to, to determine if any of their members would be interested in participating in the interviews:

- «Blindeforbundet», which is an organization for blind people in Norway. I contacted them by sending an email and got a reply that they would include the request in an electronic newsletter that they sent out to their members and their members who were interested could reach out through email. There was one willing participant from Blindeforbundet.
- «Landsforeningen for ryggmarksskadde (LARS) », the Norwegian Spinal Cord Injuries Association was a fitting candidate organization to reach out to due to many of their members had greatly reduced mobility. I contacted them by sending them an email and got a reply that they would forward the request to their Facebook group and add the contact information that would be used to reach out to me, if interested. There was one willing participant from LARS.
- «Uloba – Independent Living», was an organization that focuses on accessibility and inclusion in society. A large number of employees in this organization are also people with disabilities. A colleague working on a project with Uloba as a project manager and asked some of the employees if they were interested in participating in an interview, and if so, that they could reach out through email. There were two willing participants from Uloba.
- There was one willing participant who joined through a direct referral from a colleague.

3.1.4 Interview Guide and Question Design

The purpose of the interview was to have a natural conversation with the interviewee and try to get information about their disability and find out what experiences they have had with self-service technology, and which challenges they have faced.
The original Norwegian interview guide can be found in the Appendix. All the questions and interactions are translated into English in this section. Before the interview started, the participants were greeted and thanked for choosing to participate in the interview and then notified that the recording would be started.

The interview started with an introduction about myself and introducing the project itself and the reason for me choosing this particular project and topic. The interviewees were then asked **"Tell me a little about yourself. What kind of impairment or disability do you have and what are some of the challenges or difficulties you face in your everyday life?"** This was an introduction question to get some information about the interviewee and get some information about their disability in a natural and non-stigmatizing manner. The purpose of the question was to get some context and information about what challenges and barriers someone with their type of disability or impairment might face, so that later in the interview, we could see which of these barriers also applied to self-service technology.
"Do you prefer to get help from an employee, instead of trying the self-service solution?"
This was the second question, and the purpose was to try understanding how much motivation the interviewees have when trying to use the self-service machines and how much effort they are willing to put into it. The answer might help indicate whether in their experiences with self-service machines, they deemed them to be inaccessible due to lack of motivation, or if it was due to lack of ability.

"Have you had any experience with self-service machines and/or terminals? And if so, which ones have you used and what were your experiences with them?"
This question was used to map out what type of self-service technology the interviewees had experience with. And in what context that they used them. This question was slightly reformulated and improved in later interviews because the previous formulation led to the interviewees going in depth about the issues they faced when they were using the machines, rather than explaining what the circumstances were and what context they used them in. The wording of the original question had the unintended effect of overlapping too much with the final question of the interview and making the last question somewhat obsolete.

"Which problems/challenges did you encounter when you used the self-service technology and how do you think these problems can be solved? Have you had experience with any self-service technology that was completely inaccessible?"
This was the final question of the interview, which was a set of three closely related questions in one. It was designed to get information about the universal design of the machines and terminals that they used and if any, which barriers they faced. With the final

set of questions, we could find out which of the self-service technology that the interviewees had experiences with, had the most accessibility issues.
After the final set of questions, the interview was completed, and the interview subject was again thanked for their participation. If the participants wanted to discuss or chat about other matters, then this would be where they usually can do that.

3.1.5 Conducting Interview

Due to the Covid-19 pandemic, the interviews were to be conducted online due to restrictions. Overall, this worked out well as it was easier to set up the interviews and accommodate the needs of the interviewees. From the recruitment process, 6 people got in touch and said they were willing to do the interview. After emailing them the consent form and tried to set up time for the interview that suited them. One of the participants was using a screen reader and preferred to get the consent form pasted into the email, instead of as an attachment. 5 out of those 6 got back in touch with a written consent and a time and date that suited them. Microsoft Teams was used to perform the interviews, but there were other options like Zoom or Google Meet available, if those were preferred by the interviewees. “Nettskjema-diktafon” smartphone application was used to record the interviews. This application was used due to its security when it comes to privacy. It records the interview, encrypts it, and sends it to Nettskjema. This was recommended to be used by Norwegian Centre of Research Data. At the time when the interviews were conducted, the “Diktafon” application had a limitation where it would only capture the sound through the phones microphone, and not the media sound that comes from applications inside the phone. Due to this, the interviews were conducted on a laptop, using its built-in speakers and the phone with the application turned on and recording placed besides the laptop to record the interview. Quiet surroundings were very important to capture the interview clearly and not be distracted by anything.

3.2 Heuristic Testing

Nielsen describes heuristic evaluation as:

> *Heuristic testing is a “discount usability engineering” method for evaluating*

> *user interfaces to find their usability problems. Basically, a set of evaluators inspect the interface with respect to a small set of fairly broad usability principles, which are referred to as the "heuristics".*
> *(Nielsen, 1994)*

For the testing phase, heuristic evaluation was chosen as methodology, because having multiple people evaluating compliance based on a set of principles has a narrower scope and is better suited for a project of this size. Compared to heuristic evaluation, expert review has a wider scope and digs deeper to find more usability issues, however the goal of the project is not to find how many usability issues self-service machines have, but instead evaluate which characteristics makes a self-service technology inaccessible.
While both expert review and heuristic evaluation are prone to being subjective in nature, having multiple evaluators reduces risk of personal bias.
Based on findings from the interviews, heuristic testing was to be conducted on selected categories of self-service machines. Two external evaluators with expertise and knowledge in universal design helped out with the testing. So, in total three people were performing the evaluation. Due to the physical aspects of the self-service machines being so prevalent when it comes to usability issues in the interview phase, and not the digital aspect, the heuristics that we had focus on were the seven principles of universal design (Connell et al., 1997), instead of other guidelines or principles, such as Web Content Accessibility Guidelines.

- Principle 1: Equitable Use
- Principle 2: Flexibility in Use
- Principle 3: Simple and Intuitive Use
- Principle 4: Perceptible Information
- Principle 5: Tolerance for Error
- Principle 6: Low Physical Effort
- Principle 7: Size and Space for Approach and Use

In addition to the seven principles for universal design, there were also rules and recommendations from the Norwegian Digitalization Directorate, which specified where and how self-service machines should be placed. These rules were also considered to be used as

heuristics, but the seven principles covered the rules well enough, that there would be too much overlap, so it was decided to not include them.

4 Ethical Concerns and Considerations

In this section the ethical concerns that might apply to this project will be discussed and which ethical considerations were made to address the concerns. “Guidelines for Research Ethics in Science and Technology” were some ethical guidelines that were followed and attempted to be implemented during this project (The National Committee for Research Ethics in Science and Technology, 2016). Additionally, there was a focus to on conducting oneself ethically and respectfully both during the interviews and testing phase.

4.1 Interviews

When conducting interviews, there are many things to consider when it comes to ethical concerns. There are two guidelines from “Guidelines for Research Ethics in Science and Technology” that are relevant when it comes to interviews:

1. *Researchers must respect the requirement of freely given informed consent.*
2. *Researchers must protect the privacy of their research subjects.*

One of the first things that needed to be done before starting the interviews was to fill out a notification form on the Norwegian Centre of Research Data (NSD) and get it approved to have the right to handle personal data of the participants. The personal data in question is name of the participants, their email addresses, and sound recordings. The application form is long and detailed, where things like which identifiable information will be handled have to filled out, and “Will you be processing special categories of personal data or personal data relating to criminal convictions and offences?”, where there are 8 different categories that can be checked off, for example “Racial or ethnic origin”, “Political opinions”, “Religious beliefs” and so on. For this project, the only category that applied was “Health data”, as we got information about the medical condition from the participants. Information about which technical and practical measures would be used to secure the personal data had to be provided as well.
Furthermore, information about the project itself had to be filled out, how the personal data would be handled, who would have access to it, project duration. The interview guide and an information letter had to be uploaded to the form as well. The information letter was

what was used as a consent form that was sent to the participants, giving them information about the project, people involved in the project, purpose of the project, why they were chosen to be interview, which personal data was going to be collected and how they could withdraw their consent if they wished to do so.
With the requirement from NSD with the consent form and personal data security, both of the aforementioned ethical guidelines are followed.

Before the recruitment phase for the interviews, it was decided that people with severe cognitive disabilities would not be recruited due to some considerations made, such as, would then be able to understand the questions during the interviews and if they would be able to formulate proper answers. On the other hand, person with milder cognitive disabilities like Dyslexia, Dyscalculia or Attention Deficiency Disorders would have been valuable interview subjects.

Before and during the interviews, it was important to provide all the information that the participants requested, treat them with respect, be accommodating and if they wished to leave the interview, they could do so. There were also some personal rules which were followed such as not pushing the interviewees to talk about things they do not want to talk about, not to be stigmatizing, not to interrupt them while they are talking and to not expose them to any risk. Many of those were obvious, but still important to keep in mind. Due to the interviews being done online, ethical considerations such as “not to expose the participants to any risks” were negated, and it was easy to accommodate to their needs.

4.2 Heuristic Testing

Heuristic testing does not have the same quantity of ethical concerns as interviews. It was important to act respectfully towards the two other evaluators and be accommodating towards them. When out in public and performing the evaluations, it was important to not impede, block or interfere with people who were using the self-service technology.

5 Project Results

In this section, results will be presented for the interviews and the heuristic testing. The results will then be analyzed in the discussion section.

5.1 Interviews

For the interviews, each participant will be introduced, and assigned a number and referred to as “Interviewee 1”, “Interviewee 2” and so on. Gender-neutral pronouns will be used when referring to them otherwise, as gender is not relevant in this case. The interviews will be combined and finding from all the interviews will be presented.

Interviewee 1 was born with an eye disease called macular degeneration where their vision progressively gets worse and blurrier. Their vision was reduced by over 90% and was said to be suffering from other undiagnosed visual impairments as well. Preferred to not ask for help, if possible, but sometimes would be forced to.

Interviewee 2 was someone who had lost most of their vision a decade ago and has an aide assisting them usually. Preferred to get helped by the aide or employees, found it to be awkward and embarrassing to struggle with self-service technology.

Interviewee 3 was a person using a manual wheelchair and still reasonably mobile. Described themselves as stubborn and preferred doing things by themselves instead of being helped by others.

Interviewee 4 was a person suffering from muscular dystrophy, meaning they had muscle weakness and degeneration. Due to this limited mobility, the person had to rely on an electric wheelchair and an aide for many of their daily tasks. They have very limited mobility in general and limited strength in their arms. Preferred to be able to do things by themselves, but sometimes ends up being assisted by their aide. And in other cases, they need the help of an employee.

Interviewee 5 was another person suffering from muscle dystrophy. Just like Interviewee 4, they used an electric wheelchair and had an aide to assist them. They had very limited mobility in their upper body and limited strength in their arms. Preferred to do things by themselves and only as last resort would ask for assistance.

When asked about their experiences with self-service technology, the answers were very varied, some of the participants had a lot of experiences with them, and some steered away from them, or had someone else helping them. Interviewee 1 and Interviewee 2 both had problems with self-service checkout machines when shopping, both participants suffering from severe visual impairment noted that they had problems due to not being able to see what is on the screen. Interviewee 1 said that it was due to bad contrast and being unable to find the correct buttons on the screen for some of the tasks. Usually if they were just scanning the items and paying, then it would be fine, while if they had to perform any extra tasks such as buying an item that they had to weigh, such as fruits, vegetables, or nuts, then they had to ask for help. Interviewee 2 and Interviewee 3 both stated that they preferred to have physical buttons instead of touch screen. They also stated that they had used a mobile application to scan and pay for their shopping items, this was mainly in the "Coop" retail chain, and both Interviewee 2 and Interviewee 4 said this method was much more accessible and user friendly. On top of the bad contrasts on the self-service checkout machines, Interviewee 4 and Interviewee 5 also noted that the user interface could be better and that on some of them, the interactive elements were far apart, and they had to move their arms a lot when performing their tasks, which proved to be very difficult due to the lack of strength and mobility in their arms.

All three of the interviewees that were wheelchair users also had complaints about the physical design of the self-service checkout. All three had complaints about the payment terminal, which often is mounted somewhere on the machine, and very static. They must reach to get to it, and it is often mounted too high up and the angle of the screen on the payment terminals is pointed upwards, so that they cannot see what is on the screen of the payment terminal when they are sitting in their wheelchairs. It was noted that some stores have it mounted on an adjustable arm, so that they drag it closer to them, but in most cases, the angle still could not be adjusted. There were also some difficulties for all three interviewees with where and how the main display of the self-service checkout was mounted. They all had complaints about the display being too far away, making it difficult to reach for people with low mobility. Some of the displays were tilted upwards, making lights from the ceiling reflect off the screen, making it difficult to see what is on the screen from a sitting position.

Interviewee 4 said that they would prefer to use self-service checkout where possible because it is a time-saver. They meant that none of the stores in Norway had solved the issue of inaccessible self-service checkouts. They had seen many good solutions outside of Norway, that were better suited for wheelchair users and had better universal design. They stated that some of the stores in Scotland had special self-service checkout counters that were made for people with disabilities, that were wider and shorter and had the payment terminal mounted on an adjustable arm that could be pulled towards the user. The buttons were lower down on the screen so that the users did not have to lift their arms too much to try to reach them.

The barcode scanning surface of the machines are also an issue usually as was pointed out by both Interviewee 4 and Interviewee 5. The issue is that the scanner is a raised platform, so that the users had lift the items onto the scanning platform and then lift them again to put into the shopping bag, putting physical strain on them. Interviewee 4 pointed out that they had been in a store, where the scanning platform was large, and not a raised platform, so the items could just be dragged across, instead of having to be lifted there. They also said that one of the stores that they had been to, had a self-checkout machine where one could attach the shopping bag to the scanning platform, so that they just had to lift the items to the scanning platform, and could just drag it into the bag scanning, reducing the physical strain.

When it comes to ticket machines, for example for the metro, or train, the interviewees had many of the same accessibility problems as the self-service checkout machines. Interviewee 1 stated that “Ruter” metro ticket machine had bad contrast on the user interface and that they had to learn by trial and error what was written on each of the buttons on the screen. Another deprecating factor was the placement of the machines, and that they were often placed somewhere where the sun would shine on the screen, making it impossible to see what is on the screen. In this case, good contrasts in the user interface would be of minimal help. They do use the mobile application, which is much easier to use, to buy the ticket most of the times, but said that they sometimes forgot the phone or that it ran out of battery charge, so they were forced to buy the tickets on the ticket machine. This might also be an issue for someone that is visiting from out of town, that does not have the mobile

application and is unaware of it. They had many of the same issues when buying a ticket for the regional train and airport express train, but stated that they rarely travel alone, so there is always someone there to help them.

Interviewee 2 stated that when using ticket machines, they always had to have someone else click on the options on the screen and afterwards they would themselves insert their payment card and enter their pin code. They would have preferred if there was an option to zoom in or make the text on the screen larger. They also repeated that they dislike touch screens and would prefer physical buttons due to these problems but reckons that the trend of more touch screens and less physical buttons is not going to change. Interviewee 2 always prefers to use mobile application if they have the option.

Interviewee 4 stated that some ticket machines are difficult to get close enough to, in order to interact with when sitting in a large electric wheelchair, with limited upper body mobility. Due to the screen being in an indented position on some of the ticket machines, the user had to stretch their arm far. The buttons on the screen are usually very spread out, forcing the user to move their arm a lot, exerting a lot of physical effort. The payment terminal is placed far away from the screen, so that they had to reposition their electric wheelchair when they were going to pay. This would sometimes cause a timeout, forcing them to start the process all over again, due to them taking too long to reposition their chair and get through the payment process. They said they preferred to buy the tickets through the mobile application or get help from their aide when buying them on the ticket machine due to these problems. Interviewee 5 had many of the same issues, but also pointed out that the area where the ticket is printed out into is too far down, making it difficult for them to reach it without almost falling out of their wheelchair.

When it comes to ATMs, Interviewee 1 stated that not only is it difficult to see what is on the display, but that they also had problems when trying to enter in their pin code, due to the keyboard being different on many of the ATMs, so they had difficulties finding where the “OK” button was. Interviewee 4 said there were many issues with ATMs for wheelchair users as well. Difficulty due to height of the machine, reach and placement. Some ATMs are placed in areas where wheelchairs can reach them, up some stairs or on a raised platform.

Interviewee 5 stated that they did not have much experience with ATMs, due to being unable to reach them in their wheelchair.

When it comes to check-in machines at the airport, while Interviewee 1 said that they generally had no issues with them, Interviewee 4 and Interviewee 5 had some issues with those machines. They pointed out many of the same issues that they had with some of the other machines, for example things on the screen being too far apart, on screen keyboard being large, making it physically straining to fill out the booking reference and surname and such. They are generally too tall, making it so that wheelchair users must stretch their arms upwards to reach the screen. They also had the same problem as some ticket machines printing the tickets too far down, in this case, the luggage tag being printed far down, making it really difficult to reach from electric wheelchair. Interviewee 4 said that usually one does the check-in through the mobile application, but if one has luggage that needs to be checked-in, then one must use one of the check-in machines because there are usually not that many manned check-in counters, so the queues are long.

Interviewee 1 had also some general complaints about some self-service machines that had a physical design where the screen was indented or positioned in a way that made it difficult for people to get close enough to see what is on the screen, and even though the user group that is affect by this is relatively small, it is still an important issue to fix due to them being completely shut out from some of the services. Interviewee 5 also had issues with this for different reasons, for them, it was difficult because they had to stretch their arm far to interact with the screen. They stated that they would prefer it if the screen and buttons were closer to them, and if the height of the touchscreen would be adjustable. Interviewee 4 also said that adjustable height would have been a really good solution, increasing accessibility for everyone.

Interviewee 3 and Interviewee 5 both said that they drove cars and Interviewee 3 stated that a lot of the petrol stations had a lot of accessibility problems, making it difficult for them to fill petrol, while Interviewee 5 said they never fill petrol themselves, instead have their assistant fill it because it is impossible for them. The issue with petrol stations, as stated by both Interviewee 3 and Interviewee 5 is that there is a raised platform around the pump,

making it hard to get close to the pump, nozzle, and the screen. For Interviewee 5 this was made even harder due to their electric wheelchair, meaning that if they were to attempt to fill petrol, then they would have to park their car further away from the pump in order to have enough room for their electric wheelchair between the car and the pump, and even if they stretched their arms out completely, they would be unable to perform the task. Interviewee 3 stated that the screen and payment terminal is way too far up as well, and that they could barely reach it, but would still have difficulties seeing what was on the screen. Some screens are also thick, so if one looks at them from an angle, and tries to click on something, their aim would be off and be unable to click on what they were trying to click. Interviewee 3 pointed out that petrol stations were lagging behind when it comes to innovation and have been the self-service technology that has seen the least amount of improvement in the last years.

Parking ticket machines had many of the same problems as the petrol station. Interviewee 5 said that due having to get up a curb to reach the parking ticket machine, or even worse that the parking ticket machine is placed on an “curb island” which does not have enough space for a wheelchair, then some of them are completely inaccessible when using an electric wheelchair. Interviewee 3 talked about many of the same issues but stated that if the parking ticket machine was on an “curb island” then it was very difficult to them because they had to lift the front wheels of their manual wheelchair up onto the curb but did not have enough room for the whole wheelchair, so they had to try to reach the ticket machine from that position. Many of the same issues as many of the other self-service technology mentioned in the interviews also applied to these parking ticket machines, where the interactive interface is too far up, cannot see what is on the screen. Contrast problems, sun reflecting on the screen. Both interviewees said that luckily parking mobile applications are becoming more and more popular and that some parking places have license plate recognition, and you pay using “autoPass”.

Interviewee 4 also talked about the self-service machines at fast food restaurants such as McDonalds and Burger King and how are not accessible due to being too tall and being unable to reach many of the buttons on the screen. They also talked about how some McDonalds restaurants abroad had screens that had a button on the screen to make the

screen much smaller, so that all the buttons are closer together and more accessible from a sitting position.
Generally, all the interviewees felt that many of the self-service technology they used was badly designed and many of the issues could be seen throughout their experiences with the different machines, such as screens being too high up, angled upwards, contrast problems, physical design making the machine inaccessible, machine being placed in an inaccessible area to name a few.

5.2 Heuristic Testing

Tests were performed on many of the machines that the interviewees mentioned such as:

- Self-checkout in stores
- Ticket Machines (Train, Metro)
- Petrol Stations
- Parking Ticket Machines

These machines were evaluated to see if they followed the seven principles of universal design. The evaluations were performed by three universal design experts and findings compounded together and presented in form of a table for each of the machine category.

Figure 4 Self-checkout in grocery store

Self-checkout	
1: Equitable Use	Some groups of users had difficulties using these machines, due to some of the problems mentioned in the other principles. For example, they did not work so well for wheelchair users and visually impaired users.
2: Flexibility in Use	There was no flexibility on these self-checkout machines, parts were not adjustable. Everything was hard-mounted, angle or distance of the different parts were not adjustable or flexible. No adjustments or alternatives for people with visual impairment.
3: Simple and Intuitive Use	For the most part the self-checkout machines were simple to use and intuitive, just scan the barcode and place the item in a bag, or the second platform. Problems arose when there were items without a barcode, such as fruits, berries, nuts. In these cases, the user had to find and select the product on the screen, and it was difficult know which brand of fruit it was and what not.
4: Perceptible Information	Contrast issues, mostly due to the screen being angled upwards towards standing users and wheelchair users getting light reflected off the screen. Payment terminal being statically mounted and too high up posed similar issues for the same user groups.
5: Tolerance for Error	For the most part self-checkout worked smoothly by just scanning the barcodes, but if there were issues, such as the barcode not being scannable then help from an employee was needed. There was also the added pressure when buying an item with no barcode, where one must choose which item it is on the screen, if one picks the wrong item there, then it might look as if you are trying to fool the system. Overall, the tolerance for error was low.
6: Low Physical Effort	Physical effort varied from store to store, depending mostly on the height difference between the platform where the items were scanned and the adjacent platforms where the items were placed prior to scanning and after scanning. Physical effort was mostly dependant the items one was purchasing, rather than the self-checkout terminal itself.

7: Size and Space for Approach and Use	While the self-checkout terminals were mostly similar in size and shape, there were still minor differences when it comes to the height, where the screen and payment terminal was placed. These differences did little to mitigate the issue of screen and payment terminal being hard to reach for customers using wheelchairs. Either the screen was placed too high up, or it was far “in”, or a combination of both. And the payment terminals had same or higher level of difficulty. Another thing to note was that there is an area where one can place the shopping basket on the left side of the self-checkout terminal, to make it easier to scan the items, however the larger basket with wheels barely fits on this platform and the user always gets the feeling that the basket might fall off the platform.

Figure 5 Train ticket machine

Train and Metro Ticket Machines	
1: Equitable Use	Some user groups such as users with visual impairment and users with motor impairments had difficulties using these machines.
2: Flexibility in Use	There were no adjustable parts, everything was fixed in place. The user interface on the screen did not have any options for customization either.
3: Simple and Intuitive Use	The process of buying a ticket was simple in its complexity and did not require any prior knowledge. The steps were easy if one did not consider the issues for users with visual and/or motor impairments.
4: Perceptible Information	There were some contrast issues when it came to the screens on these machines. Some user interface elements did not have enough contrast with the background. Quality of the screen was a factor too; it could have scratches on it or be very reflective so that it reflected light and made it difficult to read what was on the screen.
5: Tolerance for Error	They did not have much tolerance of error due to having a timeout on the payment and having to start the process all over again. A positive thing was when the user is buying tickets, only valid choices are presented, and stations that are not connected could not be selected. An issue was that sometimes, if a mistake was made, the whole process had to be started over again.
6: Low Physical Effort	The interactive elements were too far apart and required a lot of movement of the arms on the screen, but also the card reader and where the ticket is printed out was far apart too.
7: Size and Space for Approach and Use	Machines were generally placed in an accessible area, with room around the machine, but the different places on the machine that required user action such as the screen, the payment terminal and where the tickets are printed were too far apart.

Figure 6 Petrol-pump at a petrol station

Petrol/Fuel Stations

1: Equitable Use	The fuel pumps were outright inaccessible for several user groups. Even when only testing with regards to user groups who can drive vehicles, there were many problems with the fuel stations.
2: Flexibility in Use	There was no flexibility in use when it comes to the fuel pumps, there was only one way of doing it.
3: Simple and Intuitive Use	The user was not presented with too many options on the screen, making it simpler for the users to figure out what to do and how to perform the task of filling fuel on their car.
4: Perceptible Information	The screen was mounted very high up, usually at eye-level of standing users, approximately at 160 – 170 cm. This made it nearly impossible for shorter users, or users in wheelchairs to be able to see what was on the screen. Some petrol stations that did not have a kiosk and was not manned had fuel pumps that were not that tall, making them more accessible for shorter users or users in wheelchairs.
5: Tolerance for Error	Only thing worth noting related to tolerance for error was that on one of the machines, if one made a wrong choice on the user interface, they had no option to go back and change their choice and was left with the choice of waiting for the interface to time out and go back to the beginning or going to another pump.
6: Low Physical Effort	Required a physical effort to perform the task of filling fuel. Many of the petrol pump handle had a locking mechanism, but very often this did not work properly, requiring the user to continuously exert physical force through grip to keep the fuel flowing into their car.
7: Size and Space for Approach and Use	The fuel pumps were too tall for some users to be able to operate. They were also often placed on a raised traffic safety island, obviously for safety reasons, but it also made it hard with users in wheelchairs to be able to get close enough to them. The fuel pump hose was not very long, so to fill fuel, the user must park the car close enough to the pump, not leaving enough room between the car and the pump for wheelchair users.

Figure 7 Ticket machine for parking

Parking Ticket Machines

1: Equitable Use	Did not work very well for many user groups such as people with mobility impairment, visual impairment, or cognitive impairment.
2: Flexibility in Use	No flexibility or adjustability on these machines. Everything was hard mounted, and no options on the user interface. Most of them did not even have the option to choose language.
3: Simple and Intuitive Use	The whole process of buying a ticket was very complicated and difficult. Each machine had a different process, different button placement, different places where the card was inserted and where the ticket came out.
4: Perceptible Information	The display on some of these machines was very old, small, and very susceptible to sunlight reflecting off them and making it impossible to see what information was displayed on there.
5: Tolerance for Error	If something went wrong, the feedback given was not good enough to explain what went wrong or if the user did something wrong.
6: Low Physical Effort	Some older machines had physical buttons that were very hard to click and did not give the users any feedback if the click was successful or not.
7: Size and Space for Approach and Use	Placement of the parking ticket machines were often in a very inaccessible place, such as on a raised traffic safety island. Size of the parking ticket machine was too tall, making it difficult for wheelchair users to reach and use.

6 Discussion

In this section, the project results will be discussed and analysed with regards to the research questions and what discoveries were made during the literature review, interviews, and testing. After that, the scope and limitations of the project and potential future work will be discussed.

6.1 Analysis

By looking at the research question and applying and analysing the findings from the project to each of the questions, we will attempt to answer them.

6.1.1 What guidelines are available for universal design of SST?

Most of the work done in literature review is to create a clearer picture of what self-service technology is, its history, and what guidelines are available for universal design of self-service technology. While the research question itself asks for guidelines, as in what resources are available that tells engineers and developers how to create universally designed self-service technology, it was also important to investigate which standards and regulations exist that enforces the universal design of self-service technology. The findings from the literature review showed that there exists a lot of different guidelines and regulations, but most of them are unclear and in disharmony. As shown on Figure 3 Height requirements for ATMs in different standards. Source: Jokisuu, E., et al. (2018), different standards state different, sometimes contradictory things.

In Norway, The Authority of Universal Design of ICT has guidelines regarding placement of the machines. The standards for the machines are constantly being improved upon and different standardization organizations in EU are working together to harmonize the standards. The EN 301 549 is the accessibility requirements for ICT products and service in EU, and to some degree, countries outside of EU that do business with EU are also required to follow this standard. This accessibility standard is updated every few years and now the latest version of the standard follows WCAG version 2.1. The standard is a very long and broad document that covers almost everything when it comes to ICT, which is basically every

digital product one can think of. However, like most standards and regulations, these only apply to the public sector, and not the private sector. And to which degree these standards are enforced is also unknown. The equality and anti-discrimination ombud of Norway has received several complaints regarding the universal design and accessibility of many different self-service devices, such as parking ticket machines being too tall for wheelchair users, ATM having an audio-jack to connect headphones, but not actually having a screen reader.

The Norwegian Anti-Discrimination Tribunal handles hundreds of cases when it comes to discrimination based on impairment, and some of these have also been regarding self-service technology. There have been a lot of complaints that are ruled in favor of the companies that are responsible for the self-service technology, due to existing regulations not applying to the specific machine, or due to the machine being installed before the regulations came into law. It is not ideal that people have to go through the struggle of feeling discriminated against due to their impairment or disability to the point that they want to create a case at The Norwegian Anti-Discrimination Tribunal and go through the whole process, which sometimes requires legal representation. However, no government agency or authority will ever have enough resources to oversee, regulate and ensure that every service in both public and private sector complies with the existing regulations of universal design. Therefore, there will always be services that fly under the radar, so the best thing to do is to make it as easy as possible to get guidance and in some cases send in complaints.

6.1.2 What major barriers do users face when using the SSTs?

While there is some information about what major barriers users face when using SSTs in the literature review section, the main objective of the interviews was to answer this research question. During the interviews, the participants would talk about the issues and barriers that they faced when using different products. While initially the hypothesis was that most of the accessibility issues with the machines was that it is not a personal device and people don't really get the time to learn how to use it, and if it is unintuitive, then it will be inaccessible for some user groups, during the interviews and heuristic testing, the

prominent accessibility problems were the physical design and placement of the machines. This also explains why the Norwegian government chose to prioritize creating the guidelines for the placement of the machines, rather than focus on other type of guidelines.

There is also the issue of the subjectiveness of some barriers, which is pointed out by Figure 2 Fogg Behavior Model. , is that it not always the lack of ability that might be the deciding factor whether one succeeds at an action or not but might also be lack of motivation. But in either case the solution is to improve the universal design and user experience of the product.

There is a prominent mindset that accessibility and universal design is mostly for people who are blind and so many of the user groups are forgotten about. From the information gathered during the interviews and looking at the cases of the Anti-Discrimination Tribunal, something that has been clearly lacking accessibility is services related to cars and how inaccessible they are for wheelchair users. Driving is seen as something that is dangerous and a lot of responsibility is placed on the drivers themselves, and many user groups are probably forgotten about when it comes to services related to cars and drivers, due to a possible misconception that people with disabilities are unable to or should not be driving cars. For people with impaired mobility, it is important to be able to drive, due to it being difficult for them to get around in general, so anything that can increase their mobility, such as cars is a huge help for them. This however is made difficult or impossible if they are unable to perform everyday car-related tasks such as filling gas or using the parking machine.

6.1.3 Which characteristics makes an SST inaccessible?

This research question and the second research question are closely connected, two sides of the same coin. What are the major barriers that people face, and what is it that makes the SST have that major barrier, what characteristics? The heuristic testing part of the project was mostly to examine the barriers that were mentioned during the interviews by looking at similar machines and from that data, we can extrapolate what the characteristics are of the self-service technology that makes them inaccessible.

From the data, we can see that the main issues with the machines were that they required high physical effort, were inflexible and didn't have enough size and space for approach. Although there are 3 different characteristics, they are also very closely connected, as solving one of them, might to a large degree also solve other barriers. For example, if there is an information terminal, and the screen is adjustable when it comes to high, and the user can also adjust the angle of it, it solves the issue of physical effort, as the screen can be adjusted to a position where it requires less physical effort from the user, make the screen reachable easier from different positions, so it also improves the size and space for approach issue. By being able to adjust the angle of the screen, contrast issues and other issues regarding perceptibility might get solved as well.

6.2 Scope and Limitations

After the first phase of this project, there was given some feedback regarding the broad scope of the project and concerns related to this. The scope was narrowed down during the interview phase, based on the experiences of the interviewees. The research questions were also open for different interpretations and not very limited in their scope. The issue with the scope of the research questions is that they are formulated in such a way where one can never say that "this question is now fully answered", due to the number of standards, guidelines, and regulations available out there. Same thing research question 2 and 3 regarding major barriers and characteristics that makes self-service technology inaccessible, the more and the deeper one digs, the more one will find. So, while we do have findings from literature study, interviews, and the heuristic testing that answer the research questions, it's hard to say that they are final and fully conclusive.

During the interview phase, it was difficult to find participants due to the pandemic lockdown and many user groups were left out. While the interviewees provided a lot of valuable data from their experiences, it would have been preferrable to have a higher number of participants, among others some with milder cognitive disabilities, to explore some of the barriers they might face as well. This would have potentially expanded the findings, providing a clearer and more concise picture of the barriers one might face. Furthermore, during the 5 interviews that were conducted, the process was iterative,

improving the process and reformulating the questions slightly and getting more comfortable with the whole interview process, making it easier to come up with follow-up questions. With more interviews, this might have improved even more, potentially giving slightly better data.

Additionally, the seven principles of universal design might not have been the best criteria to use when conducting the heuristic testing. This is due to the criteria being subjective and making it very easy to say that a machine fails the criteria, as they are so broadly defined. For example, if a self-service technology does not follow any of the last 6 principles, one can say that it also does not follow the first principle of equitable use. These principles can be seen as overlapping, where a technology does not follow one of them, one can easily say it doesn't follow another one as well, just because of that one characteristic. In hindsight, it might have been better to use another set of heuristics, while using the seven principles of universal design as a base and inspiration. This would have provided better and more definitive results from the testing.

6.3 Future work

Since the start of this project, many things have changed. Many of the services provided by the self-service terminals and machines are now also available through alternative means such as mobile applications and other forms of technology. Ruter, the public transport authority for Oslo and Viken/Akershus has removed their ticket machines due to them not being user friendly and the claim that more than 97% of their customers bought their tickets through other means than the ticket machines. Most of the parking areas in Norway now use cameras that record the registration number upon entering and exiting the parking areas, in conjunction with a mobile application. There are many different mobile applications that can be used for parking, in cooperation with the different parking authorities. Many of the older parking ticket machines are being removed as a result, due to them being obsolete. While the mobile applications are not always the most user-friendly, making a mobile application more user-friendly is significantly easier, than a parking ticket machine, or other self-service terminals.

The technological ecosystem is constantly changing, and the lockdown due to the global pandemic is contributing to the rapid digitalization. Businesses are trying to come up with alternative ways to provide their services, which hopefully leads to more flexibility, making it easier for more people to access and use the services. Hopefully this trend continues, however there will still many different services provided through self-service machines, and therefore it is important to continue research on this topic and find ways to improve the accessibility of said machines. Additionally universal design needs to be approached as an iterative process because some accessibility barriers might be hidden behind other barriers and will only be discovered when the other ones are fixed. By having focus on universal design one can also include people with disabilities in user testing and gain even better insight into the accessibility problems a system might have.

7 Conclusion

In this thesis we have conducted literature review, qualitative interviews, and heuristic testing to learn more about accessibility of self-service technology and answer the research questions that we posed at the start of the thesis. This research will hopefully help others who are looking into accessibility of self-service technology in the future.

With the literature review we figured out what guidelines are available for accessibility of self-service technology, and while there are a lot of different guidelines, they are disharmonised and hard to follow, leaving room for different interpretations. This is also an issue due to all the different types of self-service technology, and when it comes to universal design and accessibility, there is no such thing as "one size fits all". During the literature review, we also found some research regarding what accessibility barriers users faced when using different type of self-service technology, some research focusing on specific aspects, such as touch screens, height of the machine etc.

Continuing the topic of accessibility barriers, qualitative interviews were conducted with people with disabilities, to learn about their experiences with self-service technology and what barriers they faced when trying to use them. During the interviews we found that there are many different major barriers people face when trying to use the services offered by these machines. The literature review and interviews revealed that the users faced accessibility barriers related to the contrast of the display, the physical shape and size of the machines, the machines not being placed in an area that was wheelchair accessible, and the service requiring a lot of physical effort from the users. There are most likely many other accessibility issues, but they are hidden behind one major barrier or another.

During the interviews and heuristic testing, there was also a focus on finding out what characteristics of self-service technology made it less accessible or inaccessible. One of the biggest factors were that the machines were inflexible. Machines that had adjustable parts and in general a flexible design, were perceived as more accessible than their inflexible counterparts.

In conclusion, there are many accessibility problems when it comes to self-service terminals, machines, and such technology, but technology is always shifting and evolving, and many services are moving online, as either web-services or mobile applications. While there are many potential accessibility issues with web-services and mobile applications, there are good guidelines to help companies make their services more accessible.

8 Appendix

8.1 Intervju guide (In Norwegian)

Intervjuet blir utført på en ustrukturert og uformell måte. Hensikten er å ha en naturlig samtale med intervjuobjektet og prøve å få informasjon angående deres tilstand, funksjonsnedsettelser og hvilke erfaringer de har hatt med selvbetjeningsteknologi og hvilke utfordringer de har støtt på.

Jeg jobber som frontend utvikler i Bouvet og begynte å ta master i universell utforming av IKT på deltid ved siden av jobben. Jeg jobbet med et prosjekt for Avinor for å lage interaktive informasjonsskjermer for Gardemoen flyplass, og fant ut at det var vanskelig å prøve å lage dem universelt utformet. Fant ikke så mange ressurser som fortalte meg konkret om hva som var standarden når det kommer til sånt. Derfor valgte jeg å utforske tilgjengeligheten og universelle utformingen av selvbetjeningsteknologi.

Fortell litt om deg seg. Litt om hvilke funksjonsnedsettelse du har, og hva slags utfordringer du støtter på i hverdagen?
Dette spørsmålet er et introduksjonsspørsmål for å få litt informasjon om intervjuobjektet og hvilke funksjonsnedsettelser personen har, på en naturlig og ikke stigmatiserende måte. Formålet med spørsmålet er å få litt kontekst med hva slags utfordringer intervjuobjektet støtter på i hverdagen, sånn at senere i intervjuet man kan se hvilke av disse utfordringer gjelder for selvbetjeningsteknologi.

Foretrekker du å prøve å få hjelp av en ansatt istedenfor å prøve å bruke selvbetjening?
Med dette spørsmålet prøver vi å forstå innsatsen og motivasjonen til intervjuobjektet når de bruker selvbetjening. Om de har høy motivasjon og legger inn mye innsats i å prøve å få til det de har lyst å få til gjennom å bruke selvbetjeningsautomaten, men ikke klarer det, eller om de så vidt prøver og oppsøker en ansatt med en gang.

Har du noen erfaringer med selvbetjenings automater/terminaler? Hvis så, hvilke har du brukt og hva var dine erfaringer med dem. (Gi noen eksempler på selvbetjeningsterminaler)

Formålet med spørsmålet er å få informasjon angående intervjuobjektets erfaringer med selvbetjeningsautomater. Dette er informasjon som kan brukes senere i prosjektet for ekspertevaluering av disse automatene som intervjuobjektene har hatt erfaringer med.

Hvilke problemer støtte du på når du brukte dem og hvordan tror du de problemene kan bli løst? Har du støtt på selvbetjenings teknologi som du ikke fikk til å bruke i det hele tatt?

Dette spørsmålet går ut på å få informasjon angående den universelle utformingen av automatene, om de automatene har vært universelt utformet og om brukeren støtter på noen enorme barrierer.

8.2 Consent and Information Form for the Interviews

Vil du delta i forskningsprosjektet

***" Accessibility of Self-Service Technology (Tilgjengelighet av selvbetjeningsteknologi)"*?**

Dette er et spørsmål til deg om å delta i et forskningsprosjekt hvor formålet er å analysere tilgjengeligheten og universelle utforming av selvbetjeningsteknologi. I dette skrivet gir vi deg informasjon om målene for prosjektet og hva deltakelse vil innebære for deg.

Formål

Dette er en masteroppgave som går ut på å analysere tilgjengeligheten og den universelle utforming av selvbetjeningsteknologi. Prosjektet går ut på å utforske hvilke regelverk og retningslinjer finnes for tilgjengelighet av selvbetjeningsteknologi og om disse er nok for å gjøre teknologien tilgjengelig for alle.

Skal svare på forskningsspørsmålene:

1. What major barriers do users face when using the SSTs?
   (Hvilke store barrierer møter brukerne når de bruker selvbetjeningsteknologi?)
2. Which characteristics makes an SST inaccessible?
   (Hvilke egenskaper gjør selvbetjeningsteknologi utilgjengelig?)

3. What guidelines are available for universal design of SST and do users face major barriers even though an SST follows these guidelines?
   (Hvilke retningslinjer finnes det for universell utforming av selvbetjeningsteknologi og møter brukerne på barriere selv når disse retningslinjer er fulgt?

Hvem er ansvarlig for forskningsprosjektet?
Institutt for informasjonsteknologi ved OsloMet storbyuniversitetet er ansvarlig for prosjektet.

Hvorfor får du spørsmål om å delta?
Vi har valgt å intervjue deg gjennom anbefaling fra kollegaer eller andre kjente som jobber med tilgjengelighet og universell utforming. Du har blitt valgt på grunn av temaet dreier seg om tilgjengeligheten av selvbetjeningsteknologi og da er personer med nedsatte funksjoner og evner spesielt relevante når det kommer til å finne ut om teknologien er tilgjengelig eller ikke.

Hva innebærer det for deg å delta?

Dette er et ustrukturert og uformelt intervju hvor du blir spurt litt om dine erfaringer med selvbetjeningsteknologi. Intervjuet blir tatt opp gjennom lydopptak for å senere gå gjennom den og skrive funnene fra intervjuet inn i rapporten. Alt er anonymisert i rapporten og lydopptakene blir slettet etter prosjektslutt.

Det er frivillig å delta
Det er frivillig å delta i prosjektet. Hvis du velger å delta, kan du når som helst trekke samtykket tilbake uten å oppgi noen grunn. Alle dine personopplysninger vil da bli slettet. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg.

Ditt personvern – hvordan vi oppbevarer og bruker dine opplysninger
Vi vil bare bruke opplysningene om deg til formålene vi har fortalt om i dette skrivet. Vi behandler opplysningene konfidensielt og i samsvar med personvernregelverket.

Det er bare studenten og veilederen som har tilgang til dine opplysninger.
Det vil ikke være noe identifiserbar informasjon i materialet som blir publisert.
Lydopptaket blir gjort gjennom «Nettskjema- diktafon» app, som sender lydfilene til Nettskjema som lagrer det hos «Tjenester for Sensitive Data (TSD)».
Filnavn kommer ikke til å inneholde noe som kan identifisere intervjuobjektet.

Hva skjer med opplysningene dine når vi avslutter forskningsprosjektet?
Opplysningene anonymiseres når prosjektet avsluttes/oppgaven er godkjent, noe som etter planen er september 2022. Lydopptaket av intervjuet blir slettet.

Dine rettigheter
Så lenge du kan identifiseres i datamaterialet, har du rett til:

- innsyn i hvilke personopplysninger som er registrert om deg, og å få utlevert en kopi av opplysningene,
- å få rettet personopplysninger om deg,
- å få slettet personopplysninger om deg, og
- å sende klage til Datatilsynet om behandlingen av dine personopplysninger.

Hva gir oss rett til å behandle personopplysninger om deg?
Vi behandler opplysninger om deg basert på ditt samtykke.

På oppdrag fra OsloMet Storbyuniversitet har NSD – Norsk senter for forskningsdata AS vurdert at behandlingen av personopplysninger i dette prosjektet er i samsvar med personvernregelverket.

Hvor kan jeg finne ut mer?
Hvis du har spørsmål til studien, eller ønsker å benytte deg av dine rettigheter, ta kontakt med:

- OsloMet Storbyuniversitet ved Terje Gjøsæter, tergjo@oslomet.no
- Vårt personvernombud: Ingrid Jacobsen (ingrid.jacobsen@oslomet.no)

Hvis du har spørsmål knyttet til NSD sin vurdering av prosjektet, kan du ta kontakt med:

- NSD – Norsk senter for forskningsdata AS på epost (personverntjenester@nsd.no) eller på telefon: 55 58 21 17.

Med vennlig hilsen
Terje Gjøsæter
(Forsker/veileder)

Adam Nuridov

Samtykkeerklæring

Jeg har mottatt og forstått informasjon om prosjektet «Accessibility of Self-Service Technology
(Tilgjengelighet av selvbetjeningsteknologi)», og har fått anledning til å stille spørsmål. Jeg samtykker til:

☐ å delta i intervju

Jeg samtykker til at mine opplysninger behandles frem til prosjektet er avsluttet

---
(Signert av prosjektdeltaker, dato)

8.3 Photos

Figure 8 Self-service machine in Georgia, used for many different services such as paying bills, banking, mobile courier services

Figure 9 Travel information interactive screen, Munich Airport

Figure 10 Side-view of train ticket machine

Figure 11 Parking ticket machine, picture taken from a lower position, there is no perceptible information on the display

Figure 12 Parking ticket machine, with a special enclosure to protect it from the elements, and reduce reflection from the sun on the display

Figure 13 Petrol pump

Figure 14 Self-checkout in store

Figure 15 Self-checkout in store, display is reflective

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